THE INVASIVE MOSQUITO PROJECT

by

ASHLEY THACKRAH

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A REPORT

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Approved by:

Major Professor
Dr. Natalia Cernicchiaro

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Abstract

My masters' project and field experience provided me with a variety of personal growth opportunities and taught me different aspects of the public health field. My capstone project developed a collection form and website for the Invasive Mosquito Project. One of my field experiences was with the Department of Public Health at the Fort Riley Army Installation and the other with the Riley County Health Department in Manhattan, Kansas.

Principally my project and field experience focused on learning about mosquitoes and mosquito surveillance. Government funding for mosquito surveillance activities has decreased over the years, but mosquito-borne pathogens remain a major threat to humans. Despite the lack of support, mosquito surveillance is needed to track mosquito populations and administer adequate mosquito control measures. The Invasive Mosquito Project (IMP) fulfills this role. The IMP is a citizen science project that provides young students and teachers a portal to participate in a nationwide mosquito monitoring effort. The project provides educational materials for teachers including lesson plans, PowerPoint presentations, and protocols. Students collect mosquito eggs at their home and send them to a collection center for species identification. Various mosquito species spatial distribution will be defined as additional schools across the country participate in the program.

In this report, I will discuss the project details and field experiences.

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Chapter 1 - Introduction

In the summer of 1999, a series of encephalitis cases occurred in New York City. After a thorough epidemiological investigation, the arthropod-borne virus (arbovirus) West Nile virus was determined to be the causative agent of the outbreak. West Nile is most commonly transmitted to humans by mosquitoes. In the following years, the virus spread rampantly throughout the rest of the United States. In 2000, the northeastern U.S. reported 21 cases and in 2001, a geographical area spanning 10 eastern states had 66 case reports. The virus infections peaked in 2002 when it spread across 44 different states coast to coast. A total of 4,156 cases were reported across the country, including 284 deaths (Sejvar, 2003).

Prior to 1999, the government did not fund arboviral surveillance activities, and only a few states had arboviral surveillance systems in place. The West Nile virus outbreak prompted the U.S. Government to appropriate funding to states for arboviral surveillance. In 2004, approximately $24 million was distributed to all 50 state health departments and six large city and county health departments. By 2012 and 2013, the funding was reduced by 61% to $9.3 million. Just 80% of states performed state-level mosquito surveillance in 2012, compared to 96% in 2004. Only 34% of states reported that most of their local health departments performed mosquito surveillance in 2012, as opposed to 48% in 2004. Additionally, 58% of states reduced mosquito trapping and 68% decreased mosquito testing from 2004 to 2012 (Hadler et al., 2015).

Despite these cutbacks in mosquito surveillance activities, mosquitoes and the pathogens they harbor remain a major threat to public health. Mosquitoes transmit a wide variety of pathogens that may result in deadly diseases in addition to West Nile virus, including malaria, canine heartworm, St. Louis encephalitis, eastern and western equine encephalitis, dengue, and yellow fever among others (American Mosquito Control Association, 2014). Chikungunya was

recently introduced to the U.S., in Florida, where the first locally-transmitted case was confirmed in 2014. Eleven additional locally-transmitted cases also occurred in Florida that year (Kendrick, Stanek, & Blackmore, 2014). The Centers for Disease Control and Prevention has a "Nowcast" application that determines the estimated probability that chikungunya will be transmitted locally in various U.S. cities. The "Nowcast" application determines probability by factoring in airline data, case data, and climate data to estimate the chance of at least one case occurring in that month. As an example, for June 2015, New York City had an average probability for a local transmission of 98%. Houston had a 99% probability, Atlanta 86%, and Los Angeles had a 53% probability (CDC, 2015a).

Chikungunya is a fairly debilitating disease. Symptoms of chikungunya include joint pain and swelling, fever, muscle pain, headaches, and rash (CDC, 2015b). Currently, there is no medicinal treatment or vaccine for chikungunya (CDC, 2015b). As such, bite prevention is key to avoiding infection. The chikungunya virus is most commonly transmitted to humans by *Aedes aegypti* and *Aedes albopictus* mosquitoes, both of which often bite during the day (CDC, 2015c).

Aedes aegypti, also known as the yellow fever mosquito, is an invasive container-breeding mosquito species that originated in Africa. It was probably brought to the western hemisphere on European ships during the exploration and colonization of the Americas. *Aedes aegypti* is prevalent throughout the southeastern United States. In addition to transmitting yellow fever, *Aedes aegypti* mosquitoes are a primary vector for the dengue and chikungunya viruses (Zettel & Kaufman, 2013).

Aedes albopictus is commonly known as the Asian tiger mosquito. The species was most likely introduced to the U.S. in used tires shipped from Northern Asia (Hawley et al., 1987).

Soon after its introduction, the species quickly spread across the eastern states, especially Florida, Georgia, and the Carolinas. *Aedes albopictus* is known to be a vector for several diseases that can affect humans, including chikungunya, dengue, and Eastern equine encephalitis (Rios & Maruniak, 2014).

The exact distribution of these mosquito species is unclear and fluctuating because of irregular monitoring. Mosquito surveillance involves the monitoring of adult and larval mosquito populations to support mosquito control operations. Mosquito surveillance includes determining species composition, tracking population fluctuations, and ascertaining mosquito-borne pathogens in the area, all of which help agencies decide which mosquito control activities to perform. By identifying the species present in an area, mosquito control experts can locate breeding habitats, estimate the severity of a potential outbreak, and determine which mosquito-borne diseases those species can transmit. Monitoring mosquito population levels allows agencies to compare current to previous years' data in order to locate problem areas and predict potential disease risks. Population levels and species types also help to determine which mosquito control activities to perform (Vector Disease Control International, 2015).

Mosquito monitoring plans first divide an area into control zones. In each zone, mosquitoes are collected using the dipping technique and mosquito traps. Standardized dipping techniques sample mosquito larvae from standing water. Traps capture adult mosquitoes, which are gathered the day after a trap is set and then sent to a lab to be identified. There are a variety of traps available, including Gravid Traps, New Jersey Light Traps, CDC Miniature Light Traps, and more. (Vector Disease Control International, 2015)

Mosquito surveillance efforts are crucial to reduce the disease burden mentioned earlier and must continue despite a lack of government funding. Because of the fact that the

distributions of *Aedes aegypti* and *Aedes albopictus* are uncertain, there may be mosquito-borne disease risk areas that are currently unknown and can significantly affect human and animal populations if weather conditions change or with the introduction of a new pathogen. With the prospects of scarce funding and potential disease risks, other means of obtaining surveillance data need to be attained by initiatives like the Invasive Mosquito Project.

The Invasive Mosquito Project is an initiative intended to monitor invasive container-breeding mosquito species in the United States. This project is also a citizen science project that will transform teachers and students (non-professionals) into citizen scientists. High school teachers will have the opportunity to meet national education requirements (next generation science standards) by participating, and students will learn about mosquitoes, public health, and safety. Students will gather real data outside of the classroom environment by collecting mosquito eggs, larvae, and/or pupae and return to the classroom to discuss their findings amongst their peers. Data collection is not only an important facet for the students, but also to researchers, public health professionals, and mosquito control agencies. The data collected will inform scientists of the distribution of mosquito species across the U.S., and thus determine the potential risk of disease transmission in human and animal populations.

In the state of Kansas, mosquito surveillance is only performed in Sedgwick County through the Kansas Department of Health and Environment. Their efforts are focused on trapping and testing mosquitoes for West Nile virus (KDHE, 2015a). To our knowledge, throughout the rest of the state, no other municipalities or counties conduct mosquito surveillance. The Kansas Department of Health and Environment executed a Mosquito Control Capacity Survey in 2015 in order to assess mosquito control practices in cities and counties in Kansas. Of the 285 respondents, 49% reported that mosquito control activities were performed

in their jurisdiction. However, these entities do not perform mosquito surveillance in order to guide their efforts. Instead, they conduct mosquito control simply because they have always sprayed for mosquitoes in the past (42%), it reduces the number of mosquitoes (54%), and/or because citizens request it to be done (57%) (KDHE, 2015b). It would be more beneficial for these entities to have mosquito surveillance data to direct their mosquito control efforts. However, mosquito surveillance probably cannot be performed by these municipalities and counties due to budget constraints (KDHE, 2015b).

The following chapters will provide a discussion on the Invasive Mosquito Project and my field experience at both the Department of Public Health at the Army Installation in Fort Riley, Kansas, and the Riley County Health Department in Manhattan, Kansas. Chapter 2 describes the Invasive Mosquito Project and the specific objectives I completed: a) design and create a user-friendly collection form (and a logo); and b) build a website with a central database for storing and accessing the mosquito distribution data submitted by the participating students. Chapter 3 focuses on my field experience at the Department of Public Health at the Army Installation in Fort Riley, Kansas, and the objectives I completed: a) actively engage in rotations in all the sections within the organization and learn their role in public health and the community they serve; and b) gain more experience and exposure in the vector surveillance area, especially as it relates to mosquitoes. Chapter 4 contains details of my field experience at the Riley County Health Department in Manhattan, Kansas and my objective to determine if any emergency response activities, such as surveillance, interventions, and guidelines, are conducted in Riley County regarding insect-related issues, especially mosquitoes. Finally, the appendix contains a draft of an article about IMP that will be submitted to a publication called Wing Beats.

Chapter 2 - Invasive Mosquito Project

Introduction

The Invasive Mosquito Project (IMP) is a citizen science project (activities sponsored by organizations so non-scientists can contribute to scientific research) aimed at monitoring invasive container-breeding mosquito species in the United States. This project features data collection as well as an educational component. Data collection will occur with the help of non-professional citizen scientists, such as high school science teachers and students, who will contribute to this study by participating in a nationwide surveillance to gather distribution data for invasive and native mosquito species. Monitoring of mosquitoes allows scientists to determine which species are present, and thus determine the potential risk of disease transmission in human and animal populations. As a citizen science project that meets national education requirements (next generation science standards), the project helps students gather real data while learning about mosquitoes, public health, and safety. Students will be able to contribute to a nationwide study while gaining experience collecting data in their own backyard.

Objectives of the Project

The overall objectives of the IMP are as follows: 1) Define the geographic distribution of invasive mosquito species, *Aedes aegypti* and *Aedes albopictus*, as well as of native species; 2) Determine at-risk human and animal populations based on the distributions of mosquito species; 3) Educate citizen scientists of the risk of mosquito-borne diseases; 4) Create a network of potential collectors; and 5) Build a central database to store mosquito distribution data.

Invasive mosquito species *Aedes aegypti* and *Aedes albopictus* can transmit Chikungunya and dengue viruses. Although the main emphasis of the IMP project is to collect data on invasive mosquito species, data regarding distribution of native species will also be collected.

Defining the geographic distribution of invasive and native mosquito species will provide an opportunity to discover potential high-risk areas where pathogens may be more likely transmitted via mosquitoes. As part of the educational component, IMP exposes citizen scientists to a basic understanding of mosquitoes and the pathogens that they can transmit, as well as safety measures that they can utilize to protect themselves, their family, and their pets from illness. A network of potential collectors, such as high school science teachers, is necessary for the success and sustainability of IMP. Lesson plans, PowerPoint presentations, and basic information on mosquitoes are provided to encourage teachers to participate. In order for the network of potential collectors to grow, a website and word of mouth from participating teachers are vital.

My specific objectives within the Invasive Mosquito Project included: 1) design and create a user-friendly collection form (and a logo) to assist teachers and students in entering field data; and 2) build a website with a central database for storing and accessing the mosquito distribution data submitted by the participating students.

Materials and Methods

1. Development of a logo and a collection form

One of the first steps was to create a logo to allow the project to be easily associated with a visual image. The logo was then incorporated on the collection form and website.

The project, when piloted in 2014, used a collection form that students in high school classrooms filled out and submitted. However, it was difficult to fill in, and some of the fields were deemed unnecessary. A new collection form was designed with the objective of being easy to follow by students and teachers, while being concise and only including relevant fields. The collection form contained a series of questions regarding demographics, mosquito collection, and environmental factors. Some of the fields/questions were as follows: school location; date of

placement; date of collection; number of eggs, larvae, and pupae collected; species of mosquitoes; and biotic and abiotic factors (presence of trees or other potential reservoirs).

2. Design and implementation of a website

A website with a central database (http://citizenscience.us/imp) was built to store the field data collected and submitted by students. The website is a resource for individuals participating in IMP where they can access materials such as classroom lesson plans, PowerPoint presentations, and basic information on mosquitoes and diseases that are provided to aid their learning. The website contains an "Input Data" button where participants can input their collection information that is then stored in the database, as well as a "View Data" button to access and visualize the data collected.

Results

1. Development of a logo and a collection form

A simple design was selected for the logo. Three logos (Figure 2.1 A to C) were created with the same coloring and shape, but with a different picture, depicting different mosquito representations, in the center. The mosquitoes in Figure 2.1 B and C are more realistic pictures of how mosquito silhouettes look. Figure 2.1 A is a picture of a flat version of a mosquito. The logo depicted in Figure 2.1 A was chosen given its simplicity and clarity. It was deemed that Figure 2.1 B and C were less clear as from afar they could potentially be construed as mountains or perhaps some other insect.

Figure 2.1 Images of proposed logos for the Invasive Mosquito Project

A. B. C.

For the collection form, a variety of fields were incorporated, including the school name and location, collection time frame/dates, the species collected, how many of each species, and biotic and abiotic factors. While developing the form, I realized that the order of the fields was an important aspect to take into consideration. If important fields were placed towards the bottom, there was a chance that students may fail to complete those fields if they decide to only complete part of the form. School information and dates, as well as the fields regarding mosquito collection, were positioned earlier on the form, while biotic and abiotic factors were placed at the bottom of the collection form. Multiple changes were made to field names and the way the fields were laid out on the page to ensure that the form was clear and easy to understand for participants. At first, the form stretched over two pages, and in order to prevent the possibility of fields not being filled out, the decision was made to keep the data portion (i.e., input page) to one page. On the back of the form, a diagram was included that illustrated what the eggs, larvae, pupae, and adult stages looked like for three Genera of mosquitoes. Multiple iterations of the collection form were developed and the one in Figures 2.2 and 2.3 were selected for further use.

Figure 2.2 Invasive Mosquito Project Collection Record Form page 1

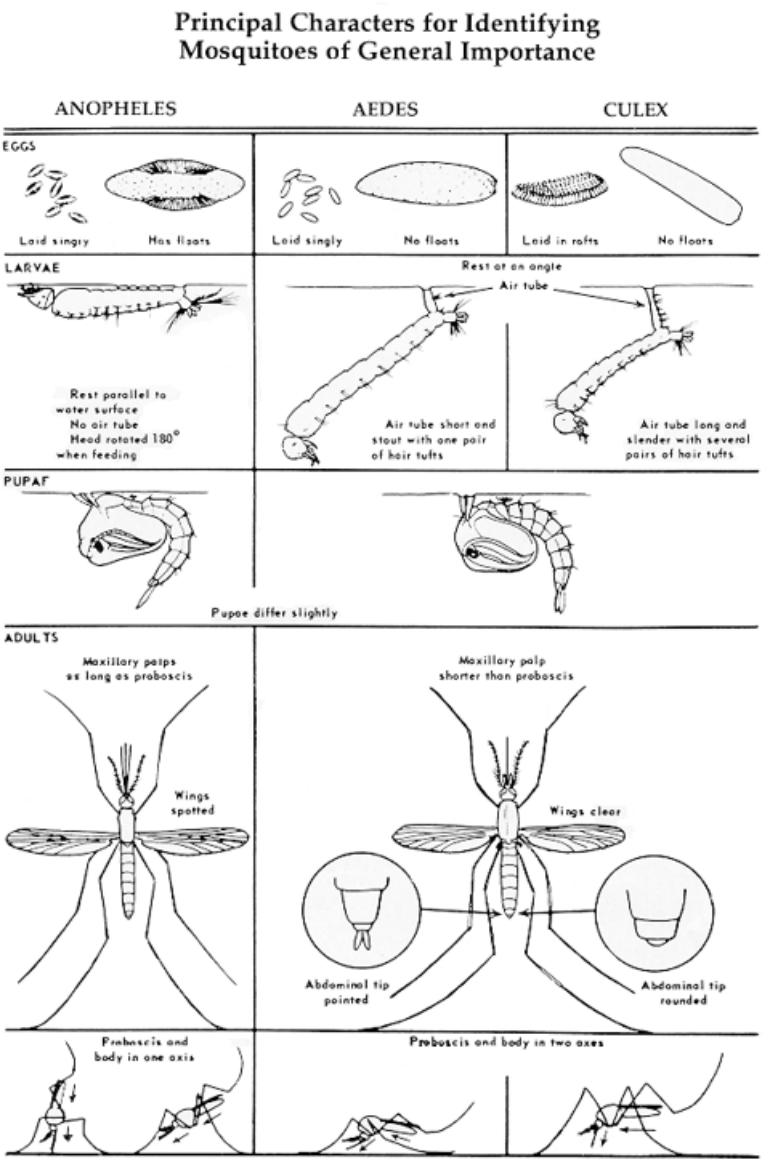
USDA

Invasive Mosquito Project

Collection Record Form

School Name:	Teacher's Name:
School's Street Address:	Date Cup was Placed (YYYY/MM/DD):
School District Number:	Date Cup was Retrieved (YYYY/MM/DD):
City/State/Zip Code:	Number of Days Cup was Outside:
County:	Collector Name(s):
How mosquito eggs, larvae, or pupae were collected (circle one or many)	Eggs: Oviposition cup  Larvae/Pupae: Open Water: Dipper cup  Contained Water: Turkey baster 
Location of cup (circle one)	Shade Sun
What mosquito stage was collected? (circle one or many)	Eggs Larvae Pupae Adults
How many?	Eggs= Larvae= Pupae= Adults=
What species of mosquito?	
Are you sending the mosquito(s) to be identified (circle one)? If yes, who is doing the identification?	Yes No
Number of individuals of each mosquito species collected	
Biotic Factors	Presence of Plants Within 5-Foot Radius of Cup (circle one or many): Trees Bushes Grass Flowers
Abiotic Factors	Temperature (°F) of Day Cup was Retrieved: Weather Conditions of Day Cup was Retrieved: Temperature (°F) Day Before Cup was Retrieved: Weather Conditions Day Before Cup was Retrieved:

Figure 2.3 Invasive Mosquito Project Collection Record Form page 2



New Jersey Agriculture Experiment Station Publication SA220-5M-86

Mosquitoes in Your Life

Donald J. Sutherland, Research Professor in Entomology and Wayne J. Crans, Associate Research Professor in Entomology

2. Design and implementation of a website

The website, http://www.citizenscience.us/imp, will be used as a resource for current and prospective project participants. The design of the website was created by a Manhattan high school student, Nolan Blankenau, over the summer of 2015. A simple, modern layout was selected as depicted in Figure 2.4. Individuals participating in the project will be able to navigate through the IMP website between four pages: Home, Collection Form, View Data, and Resources.

Figure 2.4 Screenshot of the IMP website homepage

The Home page serves as the initial landing spot for people visiting the page. It provides a brief overview of IMP, as well as two large buttons to easily access the two most important pages on the website: the Collection Form and View Data pages. The Home page will presumably also serve as a spot for important news and information to be posted in regards to the project.

The second page, Collection Form, is the page where participants can submit the collected data. The fields incorporated were obtained from the collection form and separated into three columns: School Information, Collection Information, and Rearing Information. School Information includes the fields related to the teacher and school in charge of data collection. Collection Information pertains to what was collected; options consist of eggs, larvae, pupae, and adults. Participants will fill out the sections that apply to what they have collected. Rearing Information is comprised of details regarding the mosquito species collected, by whom the species were identified, the date the mosquito species were identified, and the collector's name. The species in the dropdown list were selected based off the Walter Reed Biosystematics Unit (WRBU) site for medically important mosquitoes (which can be vectors for different diseases such as West Nile virus, Chikungunya, Dengue, Yellow fever, Eastern and Western equine encephalitis virus, and canine heartworm) (http://www.wrbu.org/northcom_MQ.html). Within the list, choices for mosquito genera are also available in case students were not able to identify the species. Finally, a Comments section allows users to add any additional information that they consider necessary. Upon submitting the form, the information provided by the user is transferred into the database of the website.

The third page of the website, View Data, is the page where data can be viewed by participants who have submitted their collection information. This page will be updated in the future to include a login and password for participants to be able to view data at the school and state levels. Currently, this page contains no information, as no data has been submitted thus far.

The fourth page, Resources, contains all the provided materials such as lesson plans, PowerPoint presentations, the printable collection form, and collection guidelines. Currently, the page holds this information for the collection of eggs, and in the future it will contain materials

for the collection of larvae and pupae. The Resources page also provides various links to sites that provide information regarding mosquitoes, control measures, and safety precautions.

Discussion

The Invasive Mosquito Project provides a multi-faceted service to the public; it is an educational tool for teachers and a data source for researchers. In order for this project to be a success, it was necessary to create an easy-to-use collection form and develop a useful and informative website with the ability to store data in regards to distribution data of mosquito species. The project will allow mosquito control agencies and public health departments to become involved in the project and work with the schools and community on educating about mosquito safety.

The logo and collection form were both integral pieces for IMP. The logo provided a visual representation for the participants to remember and identify the IMP project. The collection form offered students a resource for collecting and recording their data in an organized and structured manner. The collection form was an opportunity to decide and focus on the fields and questions that were of importance to the project.

The website was built to be a resource for IMP and to aid in attracting current and prospective participants. The site contains all the information, lesson plans, PowerPoint presentations, and mosquito safety measures regarding the project that teachers may need to assist them in starting or continuing the project. For students, the website serves as a central location to input data, view data, and find information on mosquitoes that they may be interested in. The website name, http://www.citizenscience.us, was chosen with the hope that in the future, other citizen science projects will be added into this platform. There were some challenges in constructing the website. Not having any web development experience made creating a website

intimidating. This challenge became an opportunity which allowed me to increase my knowledge and experience with computer coding. Another challenge was determining how the website should be formatted and designed. The site needed to be accessible and easy to navigate. A series of meetings with Nolan Blankenau took place to discuss how to construct the website, and at each meeting, refinements were made in the layout and design of the website. Through these meetings and modifications, the website became a user-friendly resource for project participants.

The creation of the website's database was another important objective of the project. The database will store all the data that contributors have collected. This database will be beneficial to both contributors and researchers. Contributors of the project will benefit by being able to view retrospective and current data which can be used for reports or projects in the classroom. We anticipate the database will also permit contributors to have access to data provided for their state allowing them to compare their local data with the one for the state. Researchers will be able to inspect the data and examine the distribution of mosquito species by location and time of collection.

Through IMP, a network consisting of teachers, public health professionals, and mosquito control agencies will be formed. Teachers will benefit from IMP by having educational materials that they can use in the classroom. Public health professionals and mosquito control agencies will benefit by having an opportunity to educate the public on mosquito safety, as well as being able to reference the data collected in order to determine mosquito distribution in their area and identify potential risks. Mosquito control agencies can also teach the public how to be proactive homeowners to reduce the chance of unknowingly providing breeding habitats for mosquitoes.

An additional task related to the project was to write an article for Wing Beats, a publication of the American Mosquito Control Association, which is published every quarter by the Florida Mosquito Control Association. The article, "The Invasive Mosquito Project: A public education tool" (Appendix A), describes the Invasive Mosquito Project as a citizen science project that will provide distribution data for mosquito species. The article targets mosquito control agencies to inform them of this project and how they can utilize IMP as an educational tool in their communities and form partnerships with teachers in their districts.

Chapter 3 - Field Experience at Fort Riley Army Installation

Introduction

At my public health field experience at the Department of Public Health (DPH) at the Army Installation in Fort Riley, Kansas, I completed 180 hours from August 17th to October 1st of 2015. Colonel Paul Benne, Chief of the Department of Public Health at Fort Riley was my preceptor. The main objectives of this experience were: 1) actively engage in rotations in all the sections within the organization and learn their role in public health and the community they serve, and 2) gain more experience and exposure in the vector surveillance area, especially as it relates to mosquitoes.

Fort Riley is located in the Flint Hills of Northeast Kansas. This U.S. Army installation is home to the 1st Infantry Division, which is also known as the "Big Red One". Approximately 19,400 active-duty service members are assigned to Fort Riley, and more than 53,000 individuals (24,700 family members, 20,000 retirees, and 8,500 civilian employees) live and/or work at Fort Riley ("1st Infantry Division and Fort Riley Guide and Directory 2014-15", 2014). The Fort Riley Department of Public Health at Irwin Army Community Hospital is tasked with providing a variety of health services to ensure the wellness of these individuals.

The Department of Public Health consists of multiple sections that work together to uphold their mission, which is "to promote health and wellness, and to prevent disease and injury of Soldiers and their families, military retirees, and Army Civilian employees at Fort Riley through workplace and community health" ("Department of Public Health June 2014 Newsletter", 2014). The sections that make up the framework of the Department of Public Health consist of Environmental Health, Army Wellness Center, Army Public Health Nursing, Occupational Health, Industrial Hygiene, and Army Hearing Program (Figure 3.1).

Figure 3.1 Fort Riley Department of Public Health Diagram of Sections

Image taken from Fort Riley Department of Public Health Facebook page

Another section that works closely with the Department of Public Health is Veterinary Services. Although I had the opportunity to observe and shadow all the sections within the Department of Public Health, I spent approximately a third of the time (60 hours) working at the Environmental Health section. A brief explanation of their mission and the specific activities I performed during my field experience are presented in the next section.

Rotations at the Department of Public Health's sections, Fort Riley Army Installation, Fort Riley, KS

Environmental Health

The Environmental Health (EH) section is in charge of performing activities such as monthly food service inspections, water quality testing, vector surveillance, climatic injury investigation, and medical waste monitoring. During this rotation, I had the opportunity to observe a food service inspection at a fast food facility and at one of the Child Development Centers on post. I was also introduced to the collection and processing of tap water samples

from facilities on Fort Riley to assess water quality and presence of bacteria. In addition, I participated in inspections of medical facilities on post to observe how the handling of medical waste and hazardous material (e.g., use of sharps containers and proper labelling of medical containers) was conducted.

During my rotation in this section, working under the supervision of Mr. Ronald Gerace, Sanitarian (Registered Environmental Health Specialist/Registered Sanitarian) in the Environmental Health section, I focused on learning vector surveillance methods at Fort Riley, including trapping methods for monitoring purposes, mosquito control and prevention measures, and mosquito species identification. As part of their vector surveillance program, the EH section utilizes three types of traps, namely CDC light trap, a gravid trap, and the New Jersey light trap. These traps are placed at different sites on Fort Riley considered to be at high risk of mosquito exposure, which consist of areas where soldiers and their families might work and play. Specifically, I helped set up CDC and New Jersey light traps. The next day after setting up the CDC light traps, the collection containers were harvested and brought to the laboratory for further sorting and identification of mosquitoes. After sorting the mosquitoes from the other insects, I learned, with the guidance of Mr. Gerace, how to sex and identify mosquito species. The book entitled "Identification and Geographical Distribution of the Mosquitoes of North America, North of Mexico", by Richard F. Darsie Jr. and Ronald A. Ward (2005) was used to assist the identification of mosquitoes. Besides learning that identification of mosquitoes requires a lot of patience and practice, I also learned how to process and package them for shipping. The collected mosquitoes were sent to a laboratory at the U.S. Army Public Health Center, Public Health Command Region-West Laboratory Sciences Division, in Washington for

further testing. To date, this laboratory focuses mainly on West Nile virus testing in mosquitoes that have been shipped from Fort Riley and other forts west of the Mississippi River.

If the number of mosquitoes collected in the traps on post increase by 10x or more, EH then searches for larval habitats. They identify potential water sources in nearby areas that may be the mosquito larvae development sites. By working closely with the Directorate of Public Works-Pest Control unit on Fort Riley, in those situations, EH implements control strategies to reduce mosquito populations. The two main control methods implemented are fogging, to control adult mosquitoes, and B.t.i. Briquets for the larval stage (Summit Chemical Co., Baltimore, MD).

Fogging on Fort Riley is done through a contracted service with Best Pest Control of Manhattan. In order to practice fogging, certain variables such as time of day and weather need to be taken into consideration. Fogging on post is not practiced every day; this practice is used sparingly because mosquitoes can potentially build up a resistance to the pyrethroids, which are the active chemical ingredients in the insecticidal fog.

B.t.i. Mosquito Briquets are floating sustained-release larvicide for the control of mosquitoes and psychodid fly (a.k.a. moth and sand flies) larvae with the toxins of the bacterium *Bacillus thuringiensis* subspecies *israelensis* (Bti). When placed in water, this larvacide releases Bti, a natural mosquito-killing biocontrol agent. These B.t.i. Briquets can be placed in water sources where the larval populations are high. One briquet can be used for up to 100 square feet of surface area. The B.t.i. Briquets can also be broken into portions for use near households in containers that hold standing water, such as bird baths, rain barrels, ponds, tree holes, old tires, flower pots, and animal watering troughs. The portion size of the briquet is based on the amount

of surface area of standing water. For 1 to 5 square feet, one-fourth of a briquet is sufficient; for 5 to 25 square feet, one-half a briquet can be used; for 25 to 100 square feet, one briquet is required; and for above 100 square feet, one briquet per 100 square feet of standing water should be used (http://www3.epa.gov/pesticides/chem_search/ppls/006218-00047-20030623.pdf).

We toured Fort Riley looking for standing water that may act as potential breeding sites for mosquitoes. Some of the potential sites included storm drains, pools of water on the side of the road, tires and debris that could collect water, and items in residents' yards, such as kiddie pools, birdbaths, and flowerpots. Before placing a B.t.i. Briquet in a pool of standing water, a dipper cup was used to determine if the water contained mosquito larvae. Some of the areas where we placed B.t.i. Briquets were storm drains near soldier barracks, drainage ditches, and divots near housing areas.

EH and Pest Control work together to incorporate integrated pest management, meaning going beyond just applying pesticides. They educate the public on Fort Riley how to eliminate potential mosquito breeding sites around their house, as well as doing environmental cleanup on Fort Riley which may include filling in holes that can fill with water or cleaning debris and garbage in storm drains that may disturb the flow of the water and allow water to pool.

Army Wellness Center

The Army Wellness Center (AWC) serves soldiers and their families, retirees, and Army civilians to help them build and sustain good health. While the Department of Public Health as a whole focuses on health and wellness at the population/community level, the Army Wellness Center mainly focuses on the individual level. The core programs offered at AWC include health assessment reviews, general wellness education, physical fitness, health nutrition

education, stress management, and tobacco education. Health educators at the AWC deliver these primary prevention programs and empower their clients to set their own health goals and accomplish them.

To learn about some of the services they provide, I participated in body composition, metabolic testing, and exercise testing analyses. The body composition analysis was performed by an Air Displacement Plethysmograph or BOD POD which calculates the percent of fat an individual has by displacing air to determine body density. Metabolic testing was conducted by measuring my resting metabolic rate, or the amount of calories I burn at rest. During the exercise testing, my cardio-respiratory rate, flexibility, and grip were assessed while performing various physical activities.

Veterinary Services

The Veterinary Services section provides care for the Army working dogs and horses on Fort Riley, as well as for Army personnel personal pets. The staff at Veterinary Services conduct regular clinical examinations of the animals, checking for any abnormalities and talking to the owners about preventative measures to keep their pets healthy. I observed multiple appointments where the veterinarian examined the pet physically and administered vaccines for diseases such as rabies.

Another activity performed within Veterinary Services is food inspections to certify the quality of the food being provided to the people on Fort Riley via the commissary, dining facilities, and restaurants. Daily inspections are conducted at the commissary, and every morning the delivery trucks are examined to check for proper storage and temperature conditions. Fresh produce is inspected to identify if mold or anything else that would be unappealing to the customer is present. The meat cutters in the deli and meat departments are

inspected daily to ensure they are kept in good condition. In addition, food packaging is evaluated to look for openings or dents that could be potentially detrimental to food.

Army Public Health Nursing

The Army Public Health Nursing section executes activities including tuberculosis screening, disease/injury surveillance, tobacco cessation education, child and youth services inspections, and community outreach. This section investigates cases that pertain to any reportable disease such as food-borne illnesses, sexually transmitted infections, and rabies. When a positive case of a reportable disease is identified, an investigation and potential corrective measures are initiated. Findings are then reported on their military tracking system and to the state. Tuberculosis screening is also performed in order to prevent an active tuberculosis case which could affect others in the community.

Tobacco cessation education is another focus of this section. They provide information pamphlets to patients about abandoning smoking which includes some behavioral changes. Some of these changes include switching to cigarettes that patients dislike, avoiding the use of tobacco in the vehicle, maximizing the use of gum, utilizing flavored toothpicks, drinking water for addressing cravings, and cutting tobacco use by 50% by day four of the quit attempt date. Furthermore, acute risks, such as cracked lips, staining of teeth, mouth sores, and bad breath, as well as long-term risks, including oral and lung cancer, of tobacco use are discussed with the patients.

This section also performs monthly inspections of the 10 Child Development Centers on Fort Riley. These include inspecting the staff and child accounts, as it pertains to the validity and completeness of their health records and immunizations. If a child has an allergy, for instance, it must be properly documented. Classroom walk-throughs take place in order to make

sure the appropriate hand-washing and diaper changing procedures are posted, the classroom does not have any potentially harmful toys, there are no items in the children's reach that may cause harm, the cabinets have child locks, and children with allergies to food/drink products are posted with the child's picture, including the allergy and acceptable food and beverage alternatives for them. Any findings are then documented, and at the end of the inspection, the results are reported to the center's director.

Occupational Health

The Occupational Health (OH) section focuses on reducing the risk of illness and injury in the workplace for soldiers and civilians working at Fort Riley. One of the section's main duties is to perform health screenings for incoming and current employees to ensure that they have the necessary immunizations. They also perform worksite evaluations in order to identify potential hazards in the workplace and verify that proper precautions, such as wearing personal protective equipment, are followed to avoid injuries. While in my rotation in this section, I witnessed the performance of vision and hearing tests as well as the administration of immunizations to patients.

Industrial Hygiene

The Industrial Hygiene (IH) section looks at issues within the workplace environment which may include performing indoor air quality sampling, noise surveys, and ergonomics assessments. I had the opportunity to witness Industrial Hygiene section personnel conducting visits to different buildings on Fort Riley where there were concerns about the air quality, mold issues, or ergonomics.

During these visits, I was exposed to equipment this section uses for monitoring and measurement purposes. One of those tools was the TSI Velocicalc which can measure the

room's temperature, percent humidity, and pressure of the air. In addition, during a quarterly assessment of the ventilation of an isolation room, a balometer, which measures the air flow being supplied to the room and the air flow being taken out through the return vent, was used. I was also given the task to learn how to use a piece of equipment called the QuickTake 30, an air sampling pump that measures mold spores in the air. I provided a short teaching lesson to the Industrial Hygiene section on how to use this tool.

Ergonomics in the workplace is one of the main areas that the Industrial Hygiene section focuses on. Ergonomics is the study of people at work and strives to reduce stress and injuries that may be related to the overuse of muscles, bad posture, and repeated tasks (National Institute for Occupational Safety and Health [NIOSH], 2015). The Industrial Hygiene section addresses ergonomics in the workplace by making sure employees have the necessary equipment to work comfortably in their workspace. I accompanied IH to facilities on Fort Riley to meet with employees regarding ergonomics where they were asked a series of questions to determine how best to accommodate their needs, whether that included providing a different type of computer mouse or adjusting the keyboard tray.

Army Hearing Program

The Army Hearing Program's purpose is to provide hearing safety measures for Army personnel. This includes education on the risk of hearing loss and ways to mitigate hearing loss. At Fort Riley, the personnel are exposed to loud noises whether while working in a hangar or out on the missile range. I had the opportunity to speak to the audiologist in the Army Hearing Program about hearing loss, the auditory function, and how different types of ear damage can cause transitory or permanent hearing damage. The audiologist works with Army personnel to fit their hearing protection and teach them how to wear it properly. The Army Hearing Program

works in conjunction with the Industrial Hygiene section to measure the sound level of Army facilities and help determine what hearing protection would be best.

Discussion

Having the opportunity to see the inner workings of a health department proved to be very rewarding. The staff in each of the sections were friendly and more than happy to discuss their responsibilities and roles with me. It was interesting to see how each section had its own role to play within the Department of Public Health, while still working closely with other sections. For example, if the Army Public Health Nursing section had a case of Salmonellosis that occurred at a facility on Fort Riley, they can work with the Environmental Health section to investigate how it occurred.

Prior to this experience, despite being involved in the Invasive Mosquito Project, I had no previous hands-on experience with mosquitoes. My work with Mr. Ronald Gerace gave me this opportunity, and it allowed me to learn more about mosquito trapping, identification, and control strategies. Thus, my field experience and time spent at the Fort Riley Department of Public Health was beneficial and exceeded my expectations.

Chapter 4 - Field Experience at Riley County Health Department

Introduction

I completed 40 hours at the Riley County Health Department (RCHD) in Manhattan, Kansas from June 1st to the 29th of 2015. My preceptor at the RCHD was Ms. Brenda Nickel, Director of RCHD. During my time at RCHD, my main objective was to determine what, if any, emergency response activities such as surveillance, interventions, and guidelines are conducted in Riley County in regards to insect-related issues, especially mosquitoes.

Staff In-Service

I was invited to attend the June "Prepare-Prevent-Protect staff in-service" event at the RCHD which included RCHD staff, as well as some guests that work in the surrounding areas. The in-service was run by Patti Grub, the Disease Investigator for Riley County, and Jason Orr, the Public Health Emergency Preparedness Coordinator. The topics that were covered included reportable diseases in Kansas, rabies, and Ebola. A list of the reportable diseases in Kansas were presented to the group and some of the diseases were discussed in detail. This list of reportable diseases in Kansas can be found on the Kansas Department of Health and Environment (KDHE) website (http://www.kdheks.gov/epi/disease_reporting.html#forms). Rabies was one of the diseases discussed in detail; specifically, characteristics of the disease, clinical signs in animals, animal hosts, prevention, control and treatment measures were covered. Regarding Ebola, discussed topics included clinical symptoms in patients and the actions taken if the assessment of patients was indicative of Ebola. Afterwards, the different groups deliberated the steps required to handle situations related to rabies and Ebola.

Focus Group Interview

During my field experience at the RCHD, I coordinated a focus group interview with three public health professionals, which included Patti Grub, the Disease Investigator for Riley County; Jason Orr, the Public Health Emergency Preparedness Coordinator; and Steven DeHart, the Environmental Health Specialist for Riley County. The focus group interview gave me the opportunity to talk to these three individuals and ask them questions related to their positions and explain the objectives and scope of the Invasive Mosquito Project, which is a part of my MPH program research activities. In preparation for the interview, I made a PowerPoint presentation to offer some introductory information on mosquitoes, Chikungunya as an arthropod-borne disease example, and the Invasive Mosquito Project. I also provided two handouts on Chikungunya prepared by the Centers for Disease Control and Prevention (http://www.cdc.gov/chikungunya/fact/index.html). Additionally, I formulated questions that would spark discussion during the focus group interview pertaining to their roles at RCHD and what measures are in place regarding mosquito surveillance and prevention. The focus group interview took place on June 29th, 2015 at the RCHD, and lasted one hour and forty-five minutes. The questions and their responses are provided in Table 4.1.

Table 4.1 Questions and responses (not verbatim) for focus group interview conducted at the Riley County Health Department

Question	Responses
What is your current position title and your responsibilities?	Patti Grub: Disease Investigator for Riley County - Investigates diseases included in the list of reportable diseases through the state, which also includes investigation of outbreaks, unusual occurrences of diseases, exotic or newly recognized. She is contacted by the Kansas Department of Health and Environment (KDHE), which is the state health department for Kansas, from laboratories where positive cases have been detected and then initiates investigation. Jason Orr: Public Health Emergency Preparedness Coordinator - Main responsibilities are general emergency preparedness for staff and citizens in the county to be better prepared for disasters. He also works in activities related to providing public information and education on disease outbreaks. Steven DeHart: Environmental Health Specialist for Riley County – Responsibilities include environmental range water issues and sanitary issues (primarily private, sometimes public).
What is the information you need to know on a disease outbreak?	Patti Grub: Disease investigation guidelines are specific to each disease and these guidelines provide the protocols and actions for the investigator in a case investigation. For example, for an enteric disease, two or more people in unrelated households that present with vomiting and diarrhea and have eaten at same restaurant would be considered an outbreak. Jason Orr: When we receive reports on a disease or potential disease, it is usually lab work or clinical diagnosis, so we have a little bit more knowledge on what we are looking for. In regards to Chikungunya, we would need to know what the symptoms are and how they would be different from Dengue fever.
What information do you need to know about invasive mosquito species?	Patti Grub: We mainly look at the laboratory results we receive. Clinicians should probably ask where exactly their patients have traveled. Jason Orr: In reference to the handout "Information for vector control programs", it lists where the invasive species are found and the different places where the larvae may be and how to go about reducing mosquito habitats by getting rid or larval habitats. If a press release were going to be done in regards to Chikungunya, we would use this information as well as at what time of day insects may be active.

What would be your role in a situation where there is an invasive mosquito introduction or disease outbreak related to invasive mosquito species?	Patti and Jason: Investigate and educate the population through press releases and putting notices in the Epi Newsletter which goes out to clinicians in the area. Steven DeHart: There are no ordinances, so we do not spray for mosquitoes. In the county it would be difficult to control all the spots where mosquitoes may breed.
In regards to the previous question, what arboviral (arthropod-borne viruses) surveillance would be done, if any?	Jason Orr: KDHE does some arboviral surveillance. I do not know of any local health departments that have been asked to do mosquito surveillance. There are different sections and provisions in county emergency plans that are focused on vector borne diseases and trying to curb those vectors. If the vectors increase, there are provisions for them to take action to reduce vectors through pest control or reducing breeding grounds.
What type of interventions would be used to address this type of situation?	Patti Grub: We would probably defer to KDHE on what would be needed to be done. Jason Orr: There are state statutes and regulations that allow the state health officer or local health officer to institute a vector control initiative to utilize pest control and identifying and treating known breeding grounds.
Is there a plan in place to monitor for mosquitoes, especially invasive mosquitoes? Are there any disease surveillance activities currently being performed in Riley County?	All three participants responded no.
At what point would you let the community know about a disease	Jason Orr: Patti sends out a weekly email on reportable diseases that have been investigated in the past week. Patti would also call health providers, such as hospitals, to let them know if there is an increase in diseases in the community. State will also monitor local reports and

outbreak related to invasive mosquitoes, like Chikungunya?	watch for trends across the state, and if a large number of cases occur, they might do a press release and submit an alert through the Kanas Health Alert Network (KS-HAN).
What arboviral disease related to mosquitoes are reportable?	Patti Grub: West Nile, Western Equine Encephalitis, St. Louis Encephalitis which are all listed on the Reportable Diseases in Kansas document (Figure 4.1) which can be found on the KDHE website. At the bottom of the document it also mentions unusual occurrence of any disease, exotic or newly recognized, should be reported. Jason Orr: At the top of the Reportable Diseases in Kansas document, it lists the statutes which say by law what is to be reported and the different procedures, and administrative regulations that say how they do the investigation and what regulations there are for reporting.
Are there practices in place to promote protection against mosquitoes?	Jason Orr: People at the health department with administrative access to the Facebook page can post things to promote protection. For the most part, they would promote protection by using information from CDC and using the Epi Newsletter.
Who controls mosquito populations in Riley County?	Jason Orr: I do not know of any focused efforts towards controlling mosquito populations. Steven DeHart: The city used to do fogging a long time ago, but they stopped probably due to liability concerns.
Is surveillance being performed for Chikungunya in returning travelers?	Jason Orr: With Ebola, for example, when a traveler from one of the flagged countries (countries at higher risk of disease) enters the U.S., the CDC will contact each of the state health departments that the individual is traveling through to let them know where the individual is going and then they would contact the local health department of the individual's final destination. Patti Grub: Because of Ebola, clinicians are asking patients if they have traveled. We now have an isolation room for Ebola, but it also works for other things such as measles, influenza, pertussis, etc.

Figure 4.1 Reportable Diseases in Kansas

REPORTABLE DISEASES IN KANSAS for health care providers, hospitals, and laboratories
(K.S.A. 65-118, 65-128, 65-6001 - 65-6007, K.A.R. 28-1-2, 28-1-4, and 28-1-18. Changes effective as of 9/29/2014)

☎ - **Indicates that a telephone report is required by law within four hours of *suspect* or *confirmed* cases to KDHE toll-free at 877-427-7317**

ⓘ - **Indicates that an isolates must be sent to:** Division of Health and Environmental Laboratories
6810 SE Dwight Street, Topeka, KS 66620
For Isolate Questions call: (785) 296-1633

Acquired Immune Deficiency Syndrome (AIDS)
Amebiasis
Anthrax ☎
Arboviral disease (including West Nile virus, Western Equine encephalitis (WEE) and St. Louis encephalitis (SLE)) - indicate virus whenever possible
Botulism ☎
Brucellosis
Campylobacter infections
Chancroid
Chlamydia trachomatis genital infection
Cholera ☎
Cryptosporidiosis
Cyclospora infection
Diphtheria
Ehrlichiosis
Escherichia coli O157:H7 (and other shiga-toxin producing E. coli, also known as STEC) ⓘ
Giardiasis
Gonorrhea
Haemophilus influenza, invasive disease
Hantavirus Pulmonary Syndrome
Hemolytic uremic syndrome, postdiarrheal
Hepatitis, viral (acute and chronic)
Hepatitis B during pregnancy
Human Immunodeficiency Virus (HIV) (includes Viral Load Tests)
Influenza deaths in children <18 years of age
Legionellosis
Leprosy (Hansen disease)
Listeriosis
Lyme disease
Malaria
Measles (rubeola) ☎
Meningitis, bacterial ☎
Meningococcemia ⓘ☎
Mumps ☎
Pertussis (whooping cough) ☎
Plague *(Yersinia pestis)*☎
Poliomyelitis ☎
Psittacosis
Q Fever *(Coxiella burnetti)* ☎
Rabies, human and animal ☎
Rocky Mountain Spotted Fever
Rubella, including congenital rubella syndrome ☎
Salmonellosis, including typhoid fever ⓘ
Severe Acute Respiratory Syndrome (SARS) ⓘ☎
Shigellosis ⓘ
Smallpox ☎
Streptococcal invasive, drug-resistant disease from Group A *Streptococcus* or *Streptococcus pneumoniae* ⓘ
Syphilis, including congenital syphilis
Tetanus
Toxic shock syndrome, streptococcal and staphylococcal
Transmissible Spongioform Encephalopathy (TSE) or prion disease (includes CJD)
Trichinosis
Tuberculosis, active disease ⓘ☎
Tuberculosis, latent infection
Tularemia
Varicella (chickenpox)
Viral hemorrhagic fever ☎
Yellow fever

In addition, laboratories must report:
- Viral load results of reportable diseases
- ALL blood lead levels, as of 12/2002 (KCLPPP/ABLES)
- CD4+ T-lymphocyte count < 500/ µl or CD4+ T-lymphocytes <29% of total lymphocytes

Outbreaks, unusual occurrence of any disease, exotic or newly recognized diseases, and suspect acts of terrorism should be reported within 4 hours by telephone to the Epidemiology Hotline: 877-427-7317

Mail or fax reports to your local health department and/or to:
KDHE Bureau of Epidemiology and Public Health Informatics , 1000 SW Jackson, Suite 075, Topeka, KS 66612-1274
Fax: 877-427-7318 (toll-free)

Image produced and extracted from KDHE http://www.kdheks.gov/epi/disease_reporting.html

Discussion

After having had the opportunity to speak to these three public health professionals in the focus group interview, I learned that the Riley County Health Department does not have measures in place to handle invasive mosquito outbreaks, or mosquitoes in general. After learning that no mosquito surveillance is performed in Riley County, I was curious if mosquito surveillance was implemented in other areas in the state of Kansas. The Kansas Department of Health and Environment (KDHE) has a page (http://www.kdheks.gov/epi/arboviral_disease.htm) dedicated to arboviral disease surveillance in Kansas, and I learned that mosquito surveillance is only being executed in Sedgwick County (part of the Wichita, KS metropolitan area). The mosquito surveillance efforts have concentrated there because human cases of West Nile virus have occurred in this county in the past. KDHE states on that page that they use these data from Sedgwick County as a proxy for mosquito activity for the entire state. The mosquito surveillance in Sedgwick County, which is implemented from May to October each year, consists of nine sites where the Kansas Biological Survey traps mosquitoes weekly, and then the mosquitoes are identified and counted. For testing purposes, female mosquitoes known to be potential arboviral vectors are submitted to the Kansas Health and Environmental Laboratories (KHEL) in Topeka, KS. The graph presented below in Figure 4.2, extracted from the KDHE website, depicts the total number of mosquitoes and the number of *Culex* mosquitoes collected from 2013 to 2015. The *Culex* species have a separate line on the graph because they are a primary vector for West Nile virus (KDHE, 2015a).

Figure 4.2 Mosquito Surveillance in Sedgwick County, 2015

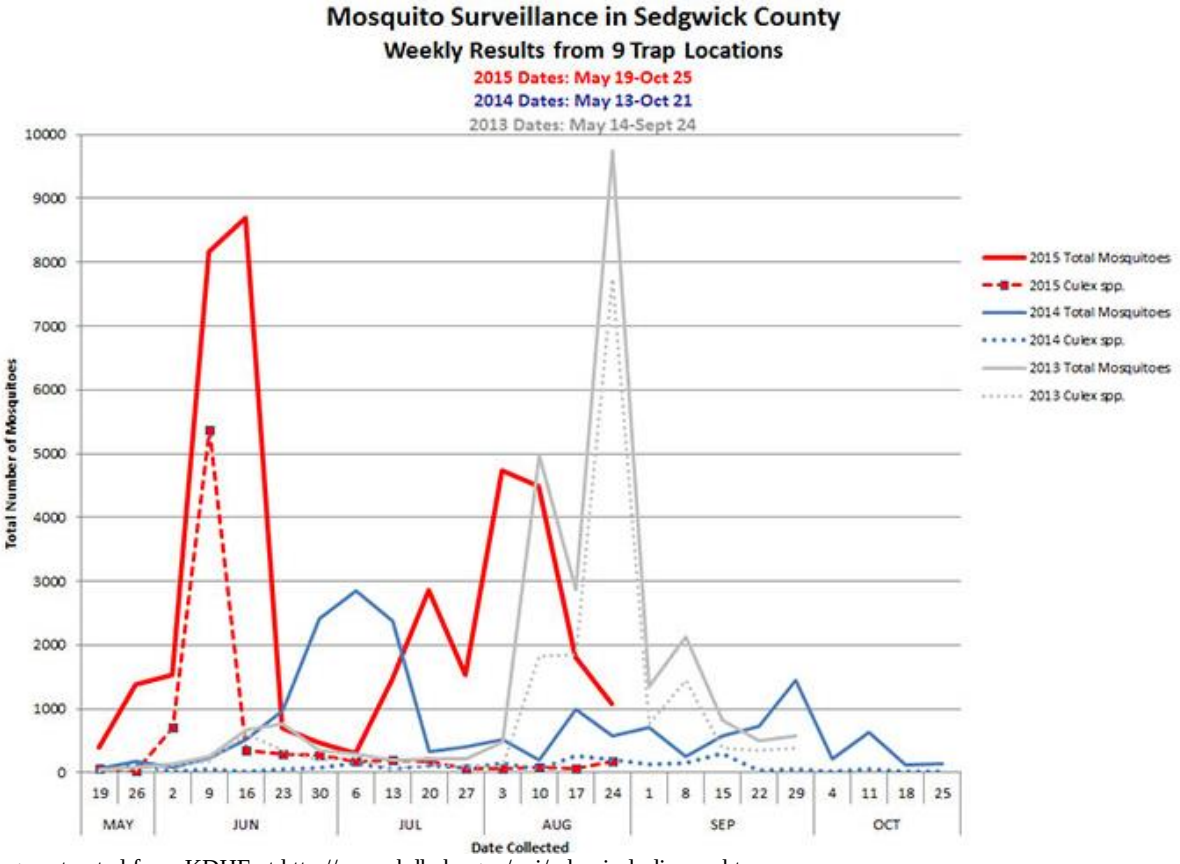


Image extracted from KDHE at http://www.kdheks.gov/epi/arboviral_disease.htm

Based on the 2015 data, the graph shows there was a large spike in the number of *Culex* species and the total number of mosquitoes in the second week of June. However, the number of mosquitoes of *Culex* species dropped sharply by the third week of June, followed by a considerable decrease of the total number of mosquitoes in the fourth week of June. The number of mosquitoes of *Culex* species stayed low for the remainder of the surveillance period, while the total number of mosquitoes began to increase in the second week of July and the first two weeks of August. A positive mosquito pool for West Nile virus was identified on August 15, 2015 in Sedgwick County. The mosquito surveillance in Sedgwick County ended August 24, 2015 due to funding constraints (KDHE, 2015a).

As mentioned previously, surveillance efforts target identification of *Culex* species as they are a primary vector for West Nile virus. However, based on the graph presented above, the number of mosquitoes of *Culex* species was lower than the total number of mosquitoes recorded. This raises several questions: What are the mosquito species that are being collected? What is the risk of these other species carrying other pathogens that could be harmful to humans? These are questions that can hopefully be answered through the Invasive Mosquito Project (IMP). IMP is mainly focusing on identifying presence or absence of container breeding mosquito species, both exotic and native species with the main goal of determining the distribution of the different mosquito species to then define human and animal health risks.

As of October 27, 2015, 26 human cases of West Nile virus have been identified in Kansas for the year 2015, as displayed in Figure 4.3. Three cases occurred in Sedgwick County and Wyandotte County, and there were two cases found in Crawford County, Ford County, and Haskell County. One case occurred in each of the following counties: Barton, Dickinson, Douglas, Harvey, Johnson, Leavenworth, Lincoln, Lyon, Marion, Meade, Nemaha, Osage, Phillips, and Reno. A star indicates where Sedgwick County, where mosquito surveillance is being performed, is located in the state of Kansas map (U.S. Geological Survey [USGS], 2015).

Figure 4.3 Human cases of West Nile virus for the state of Kansas, 2015

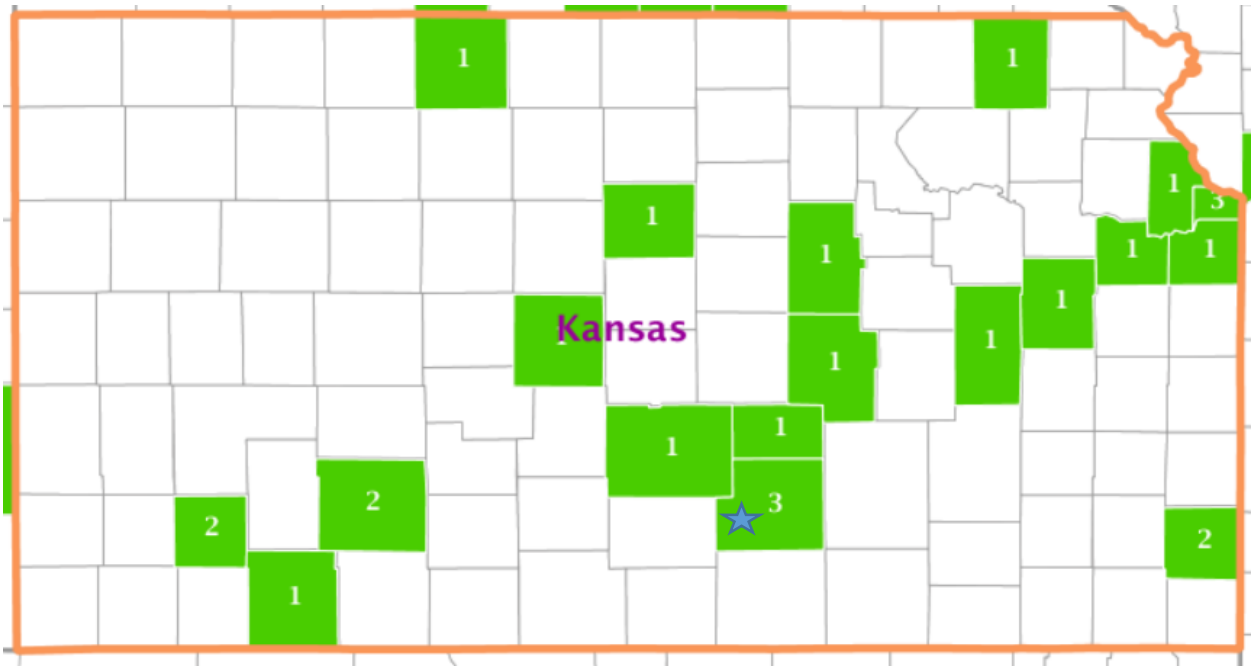


Image extracted from U.S. Geological Survey (USGS) http://diseasemaps.usgs.gov/mapviewer/ Accessed Nov. 3, 2015

Other than Sedgwick County and Fort Riley Army Installation, to my knowledge, no other mosquito surveillance efforts are being implemented in Kansas. However, the map above indicates that there are pathogen-carrying mosquitoes found in other locations across the state. High school students in different areas of Kansas will carry out surveillance activities for IMP, which will eventually expand across the United States to provide information for other states. The IMP project also aims to educate citizens regarding the risk of mosquito-borne diseases, such as West Nile virus, and teach preventative measures that they can take to decrease mosquito numbers around their house and protect themselves, their family, and their community.

The implementation of the focus group during my field experience at the RCHD was useful to learn about regulations and perceptions Kansas health officials have regarding local mosquito surveillance practices. Some of my focus group questions were very specific in regards to vectors of Chikungunya virus because one of the IMP's goals is to determine the local

and regional distribution of the mosquito species *Aedes aegypti* and *Aedes albopictus* which are competent vectors for transmitting the Chikungunya virus. Two of the questions proposed to the three public health professionals addressed Chikungunya and because there have not been any local cases in Riley County or in Kansas, they did not have specific insight on this topic. Given the locally transmitted cases of Chikungunya that were observed in Florida in 2014, and the estimated probability of local transmission for close-by cities such as Dallas, TX (probability of 94%, http://www.cdc.gov/chikungunya/modeling/index.html), future efforts should be directed towards gathering information about the distribution of its vectors locally in Kansas, regionally, and across the United States.

My field experience at RCHD provided a glimpse into the everyday workings of a public health department. It also gave me the opportunity to speak with three public health professionals to learn more about public health policies, standards, and their roles in the public health department. This experience demonstrated that the Invasive Mosquito Project can really provide a great service to Riley County and the state of Kansas by offering mosquito surveillance in areas where no surveillance initiatives are currently being performed.

Chapter 5 - Conclusion

With the emergence of diseases like Chikungunya in the U.S., along with existing diseases such as West Nile virus, mosquito surveillance is an important attribute that affects public health. Mosquito surveillance provides mosquito population and species data, which helps ensure mosquito control measures are as effective as possible. Knowing the distribution of the mosquito species that can spread disease pathogens provides an opportunity to determine potential high-risk areas for these diseases and allow public health agencies to respond and educate the public.

The Invasive Mosquito Project will serve as a source of mosquito surveillance data while also benefitting multiple entities. The project provides an educational component for teachers and students giving them the opportunity to learn about mosquitoes and the pathogens they may transmit, as well as measures to protect themselves and their family and pets. IMP also allows students to gather real data around their homes in an effort to support a nationwide study by gathering distribution data on invasive and native container-breeding mosquito species in the United States. The data collected and submitted to the online database will be of importance to researchers. Researchers can use the data to determine the geographic distribution of mosquito species that have the potential to transmit mosquito-borne diseases and thus determine the potential at-risk human and animal populations. IMP is also beneficial to public health professionals and mosquito control agencies by giving them an opportunity to partner with classrooms. While helping to identify the species of mosquitoes that the students find, public health professionals can also educate the public on mosquito safety and mosquito bite prevention during peak times of the year when mosquitoes are present. Also, based on the data, public health professionals can identify potential risks that may affect their communities and get

information to the public regarding relevant mosquito-borne diseases. This partnership will also give mosquito control agencies the opportunity to teach the community how to be proactive homeowners and reduce sources of breeding habitats for mosquitoes that are around their homes. Considering all of these benefits, IMP can be an extremely valuable program for communities across the country.

My field experiences with the Riley County Health Department and Department of Public Health at the Fort Riley Army Installation gave me the opportunity to see the inner workings of two public health departments and speak with many public health professionals at both facilities. At the Riley County Health Department, I was able to organize a focus group interview with three public health professionals, so I could discuss the Invasive Mosquito Project and learn if any mosquito surveillance or emergency response activities are in place in regards to mosquito-borne disease outbreak. This focus group was an opportunity for me to develop and present a presentation and learn more about the roles and responsibilities of public health professionals. My time at the Department of Public Health at Fort Riley provided me with the chance to rotate through each of the sections and learn how each has a main focus with responsibilities related to their section, while they also work alongside other sections. The majority of my time was spent with the Environmental Health section where I became familiar with identification of mosquitoes and gained more knowledge about mosquito surveillance. Working at both of these facilities let me experience the public health field in a live environment with real professionals. This proved to be an invaluable experience for an aspiring public health professional.

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Appendix A - Wing Beats Article (draft)

The Invasive Mosquito Project: A public education tool

Ashley Thackrah[†], Lee W. Cohnstaedt[‡*], Natalia Cernicchiaro[1]

[†]Master of Public Health, College of Veterinary Medicine, Kansas State University;[‡] Arthropod-Borne Animal Disease Research Unit, United States Department of Agriculture, Agricultural Research Service, Center for Grain and Animal Health Research, Manhattan KS 66502;

[1]Department of Diagnostic Medicine and Pathobiology, College of Veterinary Medicine, Kansas State University, Manhattan, KS 66505

*Correspondence: Lee W. Cohnstaedt, (lee.cohnstaedt@ars.usda.gov) 1515 College Ave., Manhattan KS 66502, USA

All mosquito control agencies stress the adoption of personal protective measures aimed at reducing contact with mosquitoes and their associated pathogens, such as wearing long sleeve shirts and pants, using insect repellent, avoiding outdoor activities during peak mosquito biting times, and removing larval habitat around one's home. These basic messages are repeated throughout the world in disease endemic areas, as well as in the United States during recent outbreaks of West Nile Virus and Dengue. Various public education programs throughout the country have advocated that people need to take action and be part of initiatives towards reducing mosquito habitat and pathogen transmission in their local communities. For instance, the Areawide management of the Asian tiger mosquito project (AW-ATM) is a mosquito control agency program that teaches New Jersey homeowners about mosquito habitat and their associated risks (http://www.rci.rutgers.edu/~AWATM/). These successful programs, which can be difficult to implement and maintain even locally, are not always applicable on a national scale

because they are customized to the community and require significant resources and labor to ensure continued participation. Another challenge consists of aiming to modifying attitudes and comportments of adults, the most commonly targeted audience of these programs, as they already have ingrained behaviors. Alternatively, educating children or teenagers in a classroom setting may be a more effective way to reach more individuals at a susceptible age and make a real impact in their own future and surrounding adult behavior.

Recently, the Invasive Mosquito Project (IMP) (Figure 1) (more information at www.citizenscience.us) was launched as an initiative that involves three main parties: high school teachers, high school students and mosquito control and public health professional groups. As a citizen science development, this classroom project helps high school teachers meet national education requirements (next generation science standards), and students learn about mosquitoes, public health, and safety.

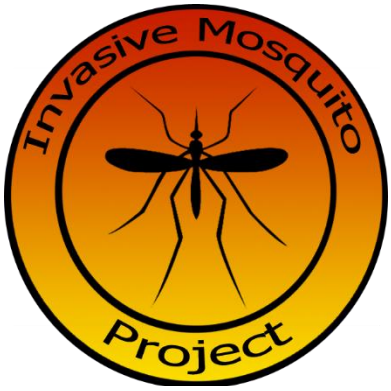

Figure A.1: Logo for the Invasive Mosquito Project

One of the main goals of the project is to transform teachers and students (non-professionals) into citizen scientists. The Invasive Mosquito Project provides educational materials, in the form of lesson plans, PowerPoint presentations, and protocols (that can be downloaded from the IMP website), for teachers and students. For instance, the first IMP lesson pertains to collection of mosquito eggs. This lesson provides students with background information, introduction to various scientific methods and teaches them to gather data and practice proper record keeping. As background information, they learn about recent mosquito introductions such as *Aedes notoscriptus* in California (http://www.glacvcd.org/2014/09/aussie-mozzie-discovered-in-los-angeles-county/), range expansion of *Aedes aegypti* and *Aedes albopictus* in 2014, and the

Figure A.2: Oviposition cup with paper lining

invasion of *Aedes japonicus* in the Northeast in 1998 (http://www.ncbi.nlm.nih.gov/pubmed/10412119). An introduction regarding potential pathogens these mosquitoes can transmit, such as Yellow fever, Dengue fever, and Chikungunya viruses or *Dirofilaria immitis*, the parasitic roundworm that causes heartworm in dogs and cats, is also provided. As part of data gathering, students will be collecting mosquito eggs around their houses, and as such there will be no additional risk of exposure to potential bites. They will place out oviposition cups with germination paper to allow container-breeding mosquitoes to lay their eggs (Figure 2). Then students will take notes on a collection form available on the project's website. After a week, upon the presence of eggs, students will bring the mosquito eggs to class and choose to raise ¼ of the eggs to adults following the protocol and safety measures provided in the lesson plan. The remaining eggs can be sent to USDA (Invasive Mosquito Project; C/O Lee Cohnstaedt; USDA-ARS; 1515 College Ave; Manhattan, KS. 66502). As part of these lessons, students gather real data outside of the classroom environment by collecting mosquito eggs, larvae, and/or pupae. Subsequently upon return to the classroom, students can examine and interpret the collected data, compare and contrast results with peers, and report findings. The data submitted by science classes are consolidated and stored by the website administrator in USDA archives and are readily available for classes to examine. As such, classes have the opportunity to assess local, regional and national mosquito distribution data and to determine if there is an increased risk of particular pathogens in their community based on the presence of certain mosquito vector species. The Invasive Mosquito Project will be an ongoing project for fall and spring quarters each year. The project continuity provides each class with the

opportunity to compare data within and between classes and across years by using retrospective data sets. Current and historic data will be available on the IMP website. Lastly, students are introduced on the impact they can make in their families and community by removing mosquito larval habitat and implementing other preventative measures.

Besides the public education component, another goal of the IMP project is to monitor invasive mosquito species in the United States. The project uses a new partnered approach to citizen science given each classroom will be "partnered" with mosquito and public health professionals that will support the lesson plans and data gathering by, for instance, confirming the students' mosquito identifications. Correct species identification is critical for obtaining accurate mosquito species distribution data. Local mosquito professionals will benefit by forming partnerships with teachers and working towards educating students regarding individuals' protection and prevention from mosquito bites as well as on strategies to control mosquito populations in the community. For professional mosquito agencies, the IMP provides nationwide mosquito surveillance, species distribution and range expansion of species, data that are collected from students in multiple high school classrooms across the country and confirmed by experts in the entomology field.

By participating in IMP, high school teachers and students contribute to a nationwide study that, while gaining experience in collecting data in their own backyard, educate them to understand their role in protecting themselves, their family, pets and the community from mosquito-borne illness. For mosquito control and other professional groups, project participation contributes to education of the public regarding prevention and control measures for invasive mosquito species as well as an effective and widespread source reduction of mosquito breeding sites.

If you are a teacher or a professional biologist, mosquito control unit, or public health agency and you are interested in public education or introducing the IMP to your local area, please consult the website (www.citizenscience.us) for more information or email us at invasive.mosquito.project@gmail.com to be listed as a project contributor.